UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NO.
08/781,920	12/30/96	FUKUNAGA	T 0756-1614

A1M1/1021
SIXBEY FRIEDMAN LEEDOM AND FERGUSON
SUITE 600
2010 CORPORATE RIDGE
MCLEAN VA 22102

EXAMINER	
PADGETT, M	
ART UNIT	PAPER NUMBER
1112	16

DATE MAILED: 10/21/97

This is a communication from the examiner in charge of your application.
COMMISSIONER OF PATENTS AND TRADEMARKS

OFFICE ACTION SUMMARY

☒ Responsive to communication(s) filed on 12/30/96.

☐ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle*, 1935 D.C. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 3 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) 1-4, 6-15 + 17-23 is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) 1-4, 6-15 + 17-23 is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☒ The proposed drawing correction, filed on 12/30/96 said to have been have never been present in the file so cannot be approved ☐ disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☒ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☒ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☒ received in Application No. (Series Code/Serial Number) 08/519,420.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____.

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of Reference Cited, PTO-892 2 copies from parent + 1 new

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). (Copy of) #4

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

-- SEE OFFICE ACTION ON THE FOLLOWING PAGES --

★ U.S. GPO: 1996-409-290/40029

1) The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

Applicant's present title describes all of class 438. While the examples are all making devices, it is noted that the claims themselves never even make any actual device.

2) Claims 1-4, 6-15 and 17-23 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In the independent claims, in their preamble, "the steps" lacks proper antecedent basis, because these are new steps. Deletion of "the" would be an appropriate correction. It is also noted that the preambles are not commensurate in scope with the steps of the claims, which are directed to various treatments done to a Si layer, but no devices are made in any of the steps, hence claims as a whole.

In claims 1(lines 5-6) and 2 (lines 5-6) "the temperature range" lacks proper antecedent basis. Also, in claims 1-2 it is noted that both the thermal annealing and the irradiating as claimed are done to the same film limitation, hence they read on actions done in either order or simultaneously. However, dependant claims 3-4, require the "non-single-crystal silicon film" to be amorphous, hence the thermal heating cannot be done

after irradiating, since the film is then crystalline, and if thermal annealing is done before the irradiating, it can not cause any crystallization, so can't contain a catalyst. For further discussion on the inconsistences contained in these claims, see section 3.

In claim 6, lines 8-10 "the crystalline silicon film" and "the crystallized silicon film" are inconsistent in their nomenclutive. See like problems in claims 11 and 14, while the phrasing in claim 14, lines 8-9 ~~are~~ is also awkward, especially with "in a nitrogen atmosphere" stuck into the middle of an idea, creating ambiguous phraseology.

In claim 6 "a metal element" is singular, hence dependant claim 7, which also includes the alternative "or a plurality of elements" is inconsistent with the independent claim, hence vague and indefinite. See analogous problems in claims 11-12 and 14-15.

In claim 13, "an interstitial element" describes the position of an atom in a solid state microstructure, however this claim does not say when in the process the limit~~ed~~ atom occurs, ie when it fits this requirement. No element is inherently "interstitial" under all circumstances.

In claim 21, the last line "the second and third steps" lack proper antecedent basis, as no steps have been so named.

3) Claims 1-4 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. On page 11 of the specification, line 6+ states "defects in a film can be reduced by preforming a heat treatment after a crystalline silicon film is obtained by laser light irradiation..." It goes on to say heating may also be done during or before, but in all cases this disclosure requires that the laser produces the crystallinity, however p. 13, lines 3-9 say the laser merely improves the crystallinity and the paragraph bridging p. 11-12 refers to Fig. 8, which discloses with succeeding discussion that only two samples (3 and 4) were actually irradiated, and all but sample 6 (not irradiated) were prepared with Ni catalyst, and heated, so were no longer amorphorous or whatever they started as. Which means 3 and 4 were both crystallized before laser irradiation hence while the laser may effect the crystallization, it was least partially ached 1eV before irradiation. It does not appear that the disclosure or data are intended to support claims 1-2 as now written, as the specification is directed to use of a catalyst to accelerate crystallization and these claims are not. Then the statements on p. 11 and on p. 12 with Fig. 8 contradict each other, since heating

before shows the highest spin density contradicting the implications of p. 11, lines 11-13 and claims 1-4 which reads on all heating possibilities. Note that p. 12, lines 17-24 show the equivalence of spin density and dangling bonds. Only sample 4 gives evidence of a decrease, as only samples 2, 3 and 4 provide any comparison. It is further noted, that one sample under specific conditions in NOT evidence of a universal trend, with any "non-single crystalline Si film "(ie produced with or without Ni) for heating then irradiating then heating. The claims with one sample supporting and one contradicting, are especially not considered to be supported.

4) Claims 6-13 and 17-23 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. No support was found in the specification for the generic "non-oxidizing atmosphere" used during a heat treatment. There were numerous examples of N_2 being used (p. 12, 17, 27, 31, and 35), but NO generalized statements. If nitrogen was not specifically stated, neither the composition of the atmosphere nor its properties were discussed, hence applicants amendment is broader than the enabling disclosure and is New Matter.

5) Claims 6-9, 11-15 and 17-23 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for irradiating an amorphous Si film, supplied with a metal catalyst which accelerates crystallization, to crystallize it when it is also heated to disclosed temperatures, does not reasonably provide enablement for use of laser alone for the initial crystallization. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to use the invention commensurate in scope with these claims. Applicant's examples, which give crystallization procedures require heating of the substrate during the laser irradiation when it is used for the initial crystallization. See embodiments 1 (p. 17, line 24+ and esp. p. 18, lines 8-13, qualified p. 16, lines 1-3); 3 (bottom p. 22-23 appears to heat and irradiate together, but laser may come second, it's ambiguous); 4 (p. 27); 5 (p. 31); 6 (p. 35) and 8 (p. 41). On p. 13, line 3 plus, where applicant discusses laser irradiation without heating, it is to improve the cryatallinity of already crystallized films, and is supported by embodiment 2 (p. 20+, note that heating is also preferred here, but not required). Embodiments 7 and 9 have no actual crystallization steps, and those generic statements concerning laser crystallization in the latter, are taken in view of like statements on p. 16 that are qualified by the actual procedures that require heating, as seen specifically on . p. 17, lines 24-27 and more generally on p. 18, lines 8-13. Applicants

may also wish to note, that while their claims require generic laser light, the examples all use various excimer lasers, mostly KrF, which are all pulsed UV lasers. While she noticed no generic teaching in applicants specification, she suspects that wavelength range used, not just intensities easily enabled by lasers, may play an important roll in the crystallization effect. ~~The invention commensurate in scope with these claims.~~

6) The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The non-statutory double patenting rejection, whether of the obviousness-type or non-obviousness-type, is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or

improper timewise extension of the "right to exclude" granted by a patent. *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969); *In re Vogel,* 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Van Ornum,* 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Longi,* 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); and *In re Goodman,* 29 USPQ2d 2010 (Fed. Cir. 1993).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(b) and (c) may be used to overcome an actual or provisional rejection based on a non-statutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.78(d).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

7) Claims 1-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takemura (762).

The only difference is that the references patterns the semiconductors into islands first, rather than before annealed, but it would have been obvious to one of ordinary skill that generic Si can be patterned at any time , and applicant's claims name no other structure.

See col. 5, lines 42-68 for various alternative laser irradiation and thermal annealing techniques, particularly thermal annealing either or both, before and after as well as during laser treatment and thermal at 550°C, a claimed temperature. See col. 7, lines 11-52 for implanting of Si substrates, then laser recrystallizing and col. 8, lines 14-40 in example 2 for laser treating amorphous silicon to improve and promote the crystallinity, with subsequent annealing at 350°C for two hours in H_2. Note teachings on reducing defects and dangling

bonds. Notice is taken when dangling bonds are reduced in number, a spin density corresponding thereto will inherently, likewise be reduced. Ex. 3 (col. 10, lines 39-45) heats the substrate (200-500°) while irradiating. Also, particularly note claims 1 & 8, where temperature ranges over lap significantly with those of applicants' claims. It is further noted that ion implanting is generally known for destroying the crystal structure of semiconductors, such as silicon, which Takemura calls "deteriorating " in col. 7. This effect is considered to inherently produce amorphous material, hence claims 3-4 are still considered to be read on by Takemura's disclosure.

(8) Claims 1-4 are rejected under ~~35 U.S.C. 112, second paragraph, as failing to set forth the subject matter which applicant(s) regard as their invention. Evidence that~~ the judicially created doctrine of obviousness-type double patenting as being unpatenable over claims 1-8 ~~fail(s) to correspond in scope with that which applicant(s) regard as the invention can be found in Paper~~ of U.S. Patent No. 5,403,762. Although the conflicting claims are not identical, they are not patenably distinct from each other, because while Takamura (same assignee, totally different inventive entities) claims generic semiconductor materials used in a particular structure, and crystallized as claimed, applicants' claims are directed to a specific materials, non-crystalline Si, possibly amorphous, used in a generic device. It would have been obvious to one of ordinary skill in the art to use one of the most commonly used amorphous semiconductors, α-Si, in Takemura's claimed process as the generic claim is suggestive of success and

the material typical or conventional, hence applicant's claimed annealing process is not patentable significant from the same annealing in Takemura's claims. Also see section 7. ~~In that paper, applicant has stated , and this statement indicates that the invention is different from what is defined in the claim(s) because .~~

9) Claims 1-4 are rejected under 35 U.S.C. 102(e) as being clearly anticipate by Zhang et al. (937).

See Abstract; Fig. 1 (etc); col. 4, lines 1-32 and 59- col. 5, line 20 and 58-col. 6, line 52, noting both thermal and radiation treatment appear to be taught to convert the amorphous area entirely to crystalline with col. 5 lines 5-10, discussing heating to 600°C in conjunction with using laser light. Particularly see col. 9, lines 15-45 for α-Si with Ni to promote crystallization where first heating at 550°C in N_2 or Ar for 4 hrs is taught, than lines 46-59 where laser light is taught to "further promote" crystallization, which is consistent with applicant's ambiguously claimed limitations. Lines 55-59 discuss the effect on dangling bonds and reduction of defects. Col. 9, lines 60-67 ~~since~~ given the next step which includes heating of the entire substrate from 300°-550°C, hence will also inherently fulfill the claimed thermal annealing which can also be a post-treatment step. Furthermore, in the making of the same device, after ion implanting (col. 10, lines 20-41), laser annealing is

preformed again (col. 10, lines 42-67) and then it is taught that "it is important that dangling bonds caused in the process of light annealing ... are neutralized by heating them at a temperature of from 250° to 400°C in the atmosphere of hydrogen in a later process" (col. 11, lines 12-16), hence cumulatively showing this concept. Note that Zhang's process involves patterns after the annealing, which can be considered to create "islands". Applicants claim do not specify what kind of patterning or islands.

(10) Claims 1-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fan et al.

As pointed out in the parent, Fan et al. teaches a laser beam amorphous to crystalline semiconductor - solid phase (i.e. lower temperature) conversion process that is catalyzed. Fan et al discusses α-Si on col. 2, line 50 - col. 3, line 30 and particularly on col. 11, line 50 - col. 12, line 25. In col. 11 and claims 1-3, 5, 10-16, 18, 20, 23-27 note the teaching of a background heating temperature used in conjunction with a (pulsed) laser, to achieve continuous, controlled motion of the crystallization front, and which would result in repeated laser treatment, than heat treatment steps. Fan et al's process is carried out in an Ar/H_2 atmosphere, ie non-oxidizing (col. 5, lines 33-40), which means that the dangling bonds would be inherently being neutralized by the subsequent or continuous

background heating that is still present after the laser irradiation has passed. Note teachings of using a metal layer of Cu, Ag, Sn, Au or other metal (col. 12, lines 1-2) next to the amorphous Si layer. Applicant's claims as amended differ from Fan et al by specifying a post-treatment of patterning into islands and a temperature for what would correspond to Fan et al's background heating. It would have been obvious to one of ordinary skill in the art to apply routine experimentation for the particular amorphous semiconductor to determine the temperature which would provide the requirements for their solid state process, which would reasonably fall within the claimed range due to known melting temperature, which one would need to be below. Fan's product is used in photovoltic cells, hence patterning the semiconductors into some sort or island would appear to be a given.

11) Claims 6-13 and 17-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fan et al (applied to claims 1-4 above) or Celler in view of Hemple et al. or Hayzelden et al. and further in view of Pressley.

In Celler, see the abstract; col. 1, lines 23-40 and 55-col. 2, line 30 for lasers to recrystallize and subsequent heating, as well as impurities, such as Cu, Ni, Fe and Au; then amorphous semiconductors, such Si in col. 3, lines 26-34 and lines 46-col. 4, line 68, esp. lines 4-14, 46 and 56-59; col. 5,

lines 18-32 and col. 6, lines 10-19. Also note pattern in the figures.

While Fan et al. does not teach use of metal elements in an interstial positon in α-Si films, either Hayzelder et al. (abstract; paragraphs 2-4) or Hample et al. (Abstract, page 921, particularly the second col., lines 8-9 where thermal annealing is done in Ar) teach α-Si with either ion implanted or co-sputtered Ni, respectively, both of which show the same phenomenon as taught in either Fan et al. or Celler of a lower temperature/quicker annealing with the presence of a metal (Ni) as a catalyst, hence it would have been obvious to one of ordinary skill that intentional introduction of metal catalyst into α-Si films would produce the same effects in the above discussed Fan et al. or Cellers, as their use of either an upper or lower very thin layer or as an impunity of unspecified source, especially as the presence of the conductive metal is all that is seen to be needed. Note Hempel's concentration is given in different units (at%) which examiner can not convert with the information available and Hayzelden et al. only give the peak concentration, hence the average for the layer would be considerably lower, probably in applicants' range, however, it would have been obvious to one of ordinary skill to optimize concentration for most advantageous annealing. Note all references teach the claimed temperatures.

Neither of the above sets of rejections teach application of the metal materials via a solution, however, applying "dopant" materials or just a layer of metal via solution is a conventional practice, and as shown in col. 3, lines 3-11 of Pressley, may be considered equivalent to vapor deposition or ion implantation when further irradiation treatment is contemplated, hence it would have been obvious to apply metals as taught by Fan et al. for annealing purposes via solutions as it puts the element in a layer in contact with the layer to be treatment and a site as claimed with the expectation of equivalent results.

Pressley is equally applicable to Celler, as both references' intent is to getter defects by metallic elemental impurities, hence it would have been obvious to use Pressleys mode of control via purposeful introduces of impurities in Celler mode of treating defects, including introduction via solution.

It is noted that solutions as discused in Pressley are commonly aqueous, hence use of water or polar solvent in such depositions would have been conventional.

Cellers et al does not specify atmospheres used, except when the particular post-treatment is intended to be an oxidizing one, but as shown in Hampel et al, thermal heating process for silicon films are known to be preformed in non-reactive atmospheres such as Ar, ie non-oxidizing also, making such an option known to be useful and obvious.

(12) Claims 14-15 and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fan et al or Celler, in view of Hemple et al. or Hayzelden et al., further in view of Pressley as applied to claims 1-13 and 17-22 above, and further in view of Liu et al or Zhang et al (5,352,291).

These claims differ by requiring their atmosphere to be N_2, however Zhang et al shows that for annealing semiconductors using heat, that N_2 is known to be an inactive atmosphere, hence obvious in view of Fan et al's use of Ar/H_2 or Hampel et al Ar. Liu et al teach annealing under analogous circumstances to Fan et al., Celler, Hemple et al or Hayzelden et al, also teaching use of catalytic metals to accelerate annealing, and teaches possible atmosphere to include argon or "other inert ambients", hence one of ordinary skill in the art would have been expect to have known which gases were inert with respect to the Si films being treat.

(13) Imahashi et al. and Moddel et al. were cited as of Interest for repetitive irradiation/heating technique. Togei show the criticality of a metal layers thickness, ie masking effects. Liu et al, and Fanash et al. may be considered equivalent to Fan et al. as previously applied, except for teaching an alternate non-laser irradiation source.

The references of Pankove et al. and Zhang et al. (291) are cited as of interest to laser annealing and thermal annealing

techniques for α-Si, as is Takayama et al. with additional catalyst teachings.

14) Claims 1-4 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-2, 8, 11-12, 15, 30-32, 34, 39, 42, 44 + 47-48 of U.S. Patent No. 6,529,937 to Zhang in view Liu et al.

Applicant's claims differ from those of Zhang et al (same assignee, no overlapping inventors), by the patent claims use of a metal catalyst and NO particular claimed heating ranges or making silicon islands. Zhang et al's substrate is specified as either "non-mmocrystal silicon film" or as amorphous, consistent with applicants' claims, and crystallizes with duel use of heat and light, possibly laser. Since in applicant's claims order of irradiation/thermal treatments don't matter, Zhang et al's specific order is irrelevant, or reads on the claims. Lui et al shows that use of metal catalysts makes temperature conditions as claimed appropriate for annealing treatments as claimed in Zhang et al, and also shows that patterning of the annealed Si is typical, ie, is suggestive of islands. In Liu et al, see col. 4, lines 4-48 and example 2 (col. 5, lines 63-col. 6, line 21) for use of temperatures such as 550°C or 650°C or 700°C under atmospheric conditions, such as use of O_2 or use of Ar or other inert ambients, where the heat source is radiant energy (col. 3, lines 26-35 and col. 2, lines 60-68). Therefore, it would have been obvious to one of ordinary skill in the art, to use the catalyst materials and atmospheres of Zhang et al in the crystallization processes of claims 1-4 of the instant application.

15) Claims 1-4, 6-15 and 17-23 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-20 of U.S. Patent No. 5,543,352 (Ohtani etal) in view of Liu etal and Fan etal.

The claims in Ohtani et al differ from applicants in they first heat, then laser irradiate their α-Si that has been treated with catalyst solutions as claimed. However, Ohtani et al has lasers and intense lamps being equivalent and Liu et al (discussed above) shows such lamps used for crystallization with catalysts, while Fan shows lasers with background heating used analogous with both using non-oxidizing atmospheres, hence it would have been obvious to one of ordinary skill that the alternate order of irradiating, then heating would have been expected to produce effective results, with solution deposition of catalyst. Note that the patterning steps added by amendment, will depend on particular devices desired. Other discussions of obviousness applied above concerning the 2° references are to be considered here also.

16) Other art of interest includes Funai et al, as well as from applicant's assignee Adachi et al (843) and Yamazaki et al (698).

17) Any inquiry concerning this communication should be directed to M. L. Padgett at telephone number (703) 308-2336 and FAX# (703) 305-3600.

M. Padgett:jmr

Oct. 14, 1997

MARIANNE PADGETT
PRIMARY EXAMINER
GROUP 1100